

**CLAIMS**

What is claimed is:

- 1    1.    A magnetic head, comprising:  
2            a sensor having a free layer, the free layer having a magnetic moment;  
3            hard bias layers positioned towards opposite track edges of the sensor, the bias  
4                    layers stabilizing the magnetic moment of the free layer;  
5            an antiparallel (AP) pinned layer structure positioned toward each of the hard bias  
6                    layers, each AP pinned layer structure having at least two pinned layers  
7                    having magnetic moments that are self-pinned antiparallel to each other,  
8                    each AP pinned layer structure stabilizing a magnetic moment of the hard  
9                    bias layer closest thereto; and  
10          an antiferromagnetic layer positioned toward each of the AP pinned layer  
11                    structures, each antiferromagnetic layer stabilizing a magnetic moment of  
12                    the pinned layer closest thereto.
- 1    2.    A head as recited in claim 1, wherein the hard bias layers each include at least Co.
- 1    3.    A head as recited in claim 2, wherein the hard bias layers are constructed from a  
2            material selected from a group consisting of CoPt and CoPtCr.

1     4.     A head as recited in claim 1, wherein the antiferromagnetic layers each include at  
2           least PtMn.

1     5.     A head as recited in claim 1, wherein the pinned layers of the AP pinned layer  
2           structure each include at least Co, wherein the pinned layers are separated by a  
3           layer of Ru.

1     6.     A head as recited in claim 5, wherein the antiferromagnetic layers are constructed  
2           from PtMn.

1     7.     A head as recited in claim 1, wherein the pinned layers of the AP pinned layer  
2           structure each include at least Fe, wherein the pinned layers are separated by a  
3           layer of Cr.

1     8.     A head as recited in claim 7, wherein the antiferromagnetic layers are constructed  
2           from PtMnCr.

1     9.     A head as recited in claim 1, wherein the AP pinned layer structures are  
2           positioned between the hard bias layers and the antiferromagnetic layers.

1     10.    A head as recited in claim 1, wherein a magnetic moment of each pinned layer  
2           closest to the associated hard bias layers is oriented parallel to a magnetic moment  
3           of the associated hard bias layer.

1 11. A head as recited in claim 1, wherein the antiferromagnetic layers each have a  
2 thickness of at least about 50 Å measured in a direction perpendicular to a plane  
3 of the antiferromagnetic layer, wherein each of the pinned layers of the AP pinned  
4 layer structures has a thickness less than about 25 Å.

1 12. A head as recited in claim 1, wherein the antiferromagnetic layers each have a  
2 thickness of at least about 100 Å measured in a direction perpendicular to a plane  
3 of the antiferromagnetic layer, wherein each of the pinned layers of the AP pinned  
4 layer structures has a thickness less than about 15 Å.

1 13. A head as recited in claim 1, wherein an Hc of each of the bias layers is at least  
2 two times an Hc of hard bias layers in a structure identical to the head of claim 1  
3 but without antiferromagnetic layers.

1 14. A head as recited in claim 1, wherein an Hc of each of the bias layers is at least  
2 three times an Hc of hard bias layers in a structure identical to the head of claim 1  
3 but without antiferromagnetic layers.

1 15. A head as recited in claim 1, wherein the head forms part of a CIP GMR sensor.

1 16. A magnetic head, comprising:  
2 a sensor having a free layer, the free layer having a magnetic moment;

3       hard bias layers positioned towards opposite track edges of the sensor, the bias  
4               layers stabilizing the magnetic moment of the free layer, wherein the hard  
5               bias layers each include at least Co;  
6       an (AP) pinned layer structure positioned toward each of the hard bias layers,  
7               each AP pinned layer structure having at least two pinned layers having  
8               magnetic moments that are self-pinned antiparallel to each other, each AP  
9               pinned layer structure stabilizing a magnetic moment of the hard bias layer  
10              closest thereto; and  
11       an antiferromagnetic layers positioned toward each of the AP pinned layer  
12              structures, each antiferromagnetic layer stabilizing a magnetic moment of  
13              the pinned layer closest thereto, wherein the antiferromagnetic layers each  
14              include at least PtMn;  
15       wherein an Hc of each of the bias layers is at least two times an Hc of hard bias  
16              layers in a structure identical to the head of claim 1 but without  
17              antiferromagnetic layers.

1   17.   A head as recited in claim 16, wherein the hard bias layers are constructed from a  
2       material selected from a group consisting of CoPt and CoPtCr.

1   18.   A head as recited in claim 16, wherein the pinned layers of the AP pinned layer  
2       structure each include at least Co, wherein the pinned layers are separated by a  
3       layer of Ru.

1 19. A head as recited in claim 18, wherein the antiferromagnetic layers are  
2 constructed from PtMn.

1 20. A head as recited in claim 16, wherein the pinned layers of the AP pinned layer  
2 structure each include at least Fe, wherein the pinned layers are separated by a  
3 layer of Cr.

1 21. A head as recited in claim 20, wherein the antiferromagnetic layers are  
2 constructed from PtMnCr.

1 22. A head as recited in claim 16, wherein the AP pinned layer structures are  
2 positioned between the hard bias layers and the antiferromagnetic layers.

1 23. A head as recited in claim 16, wherein a magnetic moment of each pinned layer  
2 closest to the associated hard bias layers is oriented parallel to a magnetic moment  
3 of the associated hard bias layer.

1 24. A head as recited in claim 16, wherein the antiferromagnetic layers each have a  
2 thickness of at least about 50 Å measured in a direction perpendicular to a plane  
3 of the antiferromagnetic layer, wherein each of the pinned layers of the AP pinned  
4 layer structures has a thickness less than about 25 Å.

1    25.    A head as recited in claim 16, wherein the antiferromagnetic layers each have a  
2           thickness of at least about 100 Å measured in a direction perpendicular to a plane  
3           of the antiferromagnetic layer, wherein each of the pinned layers of the AP pinned  
4           layer structures has a thickness less than about 15 Å.

1    26.    A head as recited in claim 16, wherein an Hc of each of the bias layers is at least  
2           three times an Hc of hard bias layers in a structure identical to the head of claim  
3           16 but without antiferromagnetic layers.

1    27.    A head as recited in claim 16, wherein the head forms part of a CIP GMR sensor.

1    28.    A magnetic storage system, comprising:  
2           magnetic media;  
3           at least one head for reading from and writing to the magnetic media, each head  
4           having:  
5           a reading portion having the structure recited in claim 1;  
6           a write element coupled to the sensor;  
7           a slider for supporting the head; and  
8           a control unit coupled to the head for controlling operation of the head.

1    29.    A magnetic storage system, comprising:  
2           magnetic media;

- 3       at least one head for reading from and writing to the magnetic media, each head
- 4       having:
- 5       a reading portion having the structure recited in claim 16;
- 6       a write element coupled to the sensor;
- 7       a slider for supporting the head; and
- 8       a control unit coupled to the head for controlling operation of the head.